

NEW GROUPS AND SPECIES BELONGING TO THE NOMINATE SUBGENUS *PARUROCTONUS* (SCORPIONES, VAEJOVIDAE)

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ABSTRACT

The nominate subgenus of the North American genus *Paruroctonus* Werner, 1934, comprises three infragroups, differentiated primarily by cheliceral and pectinal characters, and named after *P. gracilior* (Hoffmann, 1931), *P. boreus* (Girard, 1854), and *P. stahnkei* (Gertsch and Soleglad, 1966). The *gracilior* infragroup is monotypic. The *boreus* infragroup comprises four microgroups (10 species), named after *P. boreus*, *P. becki* (Gertsch and Allred, 1965), *P. xanthus* (Gertsch and Soleglad, 1966), and *P. baergi* (Williams and Hadley, 1967). The *stahnkei* infragroup comprises four microgroups (15 species), named after *P. stahnkei*, *P. shulovi* (Williams, 1970), *P. borregoensis* Williams, 1972, and *P. williamsi* Sissom and Francke, 1981. New synonyms include: *P. boreus* (= *Vejovis auratus* Gertsch and Soleglad, 1966); *P. gracilior* (= *Vejovis pallidus* Williams, 1968). New species and subspecies include: *P. bantai saratoga*, n. ssp. (southern Death Valley); *P. shulovi nevadae*, n. ssp. (southern Nevada); *P. simulatus*, n. sp. (western Great Basin); *P. coahuilanus*, n. sp. (Cuatro Ciénegas basin, Coahuila). The *gracilior* and *boreus* infragroups are primarily allopatric, but both are sympatric with the *stahnkei* infragroup. Species within an infragroup are primarily allopatric, exceptions involving essentially allotopic species.

INTRODUCTION

The scorpion genus *Paruroctonus* Werner, 1934, is distributed throughout most of western North America, and contains at least thirty species. Recently, two subgenera were defined, including *Smeringurus* Haradon, 1983, and two species groups were delimited within the nominate subgenus (Haradon, 1984a, 1984b). The complexity of this genus is revealed further by the descriptions herein of two new species and two new subspecies, prompting an effort at this time also to put the various species and groups in the nominate subgenus into a sharper hierarchical perspective. Where necessary, to clearly differentiate or synonymize species, supplementary data are given for certain previously described forms. A key complementing those in Haradon (1984a, 1984b) is also provided.

METHODS

Relatively new characters involving the tarsal and pedipalpal macrosetae are explained in the accompanying illustrations, and in more detail by Haradon (1984a). For examples of the superior setae and mid-retrosuperior (mrs) seta on the basitarsus see Figures 7-8, and for examples of the retrosuperior and retroinferior terminal setae on the telotarsus see Figures 15-16.

Most of the measurements used herein are defined by Stahnke (1970). Pectinal measurements are shown in Figures 17-18. The cheliceral fixed digit length is taken dorsally in a straight line from the digit's tip to the bicusps' proximal base. The length of each distal tine on the cheliceral movable digit is taken dorsally in a straight line from the tip to the point of common divergence; the ratio, inferior tine length/superior tine length, is primarily useful only when the superior tine is short and essentially triangular (when elongate and curved the planes and the proximal limit are indefinite).

Statistical data include the observed range (sample mean \pm one standard deviation, n = sample size). Acronyms of specimen depositories are explained below in the acknowledgments.

SUBGENUS *Paruroctonus* Werner, 1934

Uroctonoides Hoffmann, 1931:405; not Chamberlin 1920:36.

Paruroctonus Werner, 1934:283 (Jan.); Gertsch and Allred 1965:9 (subgenus of *Vaejovis* Koch, 1836; in part); Gertsch and Soleglad 1966:3 (subgenus of *Vaejovis*; in part); Williams 1972:2 (in part), 1974:15 (in part), 1980:31 (in part); Hjelle 1972:26 (in part); Soleglad 1973:353, 355 (in part); Francke and Soleglad 1981:241, 243 (in part).

Hoffmanniellius Mello-Leitão, 1934:80 (June).

Type species.—*Uroctonoides gracilior* Hoffmann, 1931.

Diagnosis.—Nominate subgenus, differentiated by: metasomal segments I-IV without short, reddish, intercarinal setae ventrally; metasomal segment III length/width ratio in adult males 1.8 or less, juveniles and adult females 1.7 or less, immatures 1.6 or less; carapace length/pectine length ratio in adult females 1.2 or more; pectinal teeth in females 22 or fewer (rarely 23 or 24); adult carapace length usually less than 6.5 mm in males and 7.0 mm in females.

Comparisons: Subgenus *Smeringurus* has numerous short, reddish, intercarinal setae ventrally on metasomal segments I-IV, and differs significantly in the other four characters above (see Haradon 1983).

Distribution.—Western North America, southern Canada southward into Aguascalientes and Baja California Sur in Mexico.

Subordinate taxa.—The subgenus *Paruroctonus* comprises three infragroups (defined below): *gracilior* infragroup (one species), *boreus* infragroup (10 species), *stahnkei* infragroup (15 species).

Vaejovis minckleyi Williams, 1968a, assigned to *Paruroctonus* by Stahnke (1974:138), exhibits only some of the characteristics that in combination define *Paruroctonus*, and is here excluded from this genus.

Remarks.—One of the more striking dichotomies in the nominate subgenus is that between the generally large species with many pectinal teeth and the generally small species with few pectinal teeth. Although there are exceptions in each group, the divergent tendencies in size and pectinal tooth counts, as well as in several coincident characters, are quite conspicuous. This dichotomy is also supported by the observations that the two groups are widely sympatric, whereas the species within each group are, with few exceptions, allopatric. However, one of the large species, *Paruroctonus gracilior* (Hoffmann, 1931), is geographically removed and morphologically divergent from the other large species, and in various characters tends to link the large and small species. The link is completed by *Paruroctonus becki* (Gertsch and Allred, 1965) among the large species and *Paruroctonus stahnkei* (Gertsch and Soleglad, 1966) among the small species, each of

which is intermediate to *P. gracilior* and most or all of the other species in their respective groups with respect to infragroup characters 1-3 (see infragroup diagnoses below) as well as in the number of retroinferior terminal setae on the telotarsi, the number of primary denticle rows on the pedipalp movable finger, and the development of denticles on the inferior carina of the cheliceral fixed digit. The various characteristics shared by *P. gracilior* and the remaining large species (i.e., infragroup characters 5-10) all appear plesiomorphic, relative to the outgroup subgenus *Smeringurus*, and thus do not necessarily support a closer relationship than one between *P. gracilior* and the small species, a relationship for which, likewise, no synapomorphies are known. Therefore, the classification that, in my opinion, best describes the available observations is one involving three infragroups; namely, *gracilior*, *boreus* (including *P. becki*), and *stahnkei*.

GRACILIOR INFRAGROUP

Diagnosis.—An infragroup of nominate subgenus *Paruroctonus* differentiated by: (1) cheliceral fixed digit with inferior carina confined distally, does not extend proximally to level of bicuspid (see Gertsch and Soleglad 1966:fig. 33); (2) cheliceral movable digit with superior distal tine essentially triangular, inferior distal tine length/superior distal tine length ratio 3.1-3.2 (see Gertsch and Soleglad 1966:fig. 35); (3) carapace length/cheliceral fixed digit length ratio 3.3-4.1 (rarely 4.2); (4) basitarsus III with five superior setae, including three distal plus two proximal (3+2; rarely 4+2, and only among arenicolous specimens); (5) pectinal teeth in males 23-32 (more than 95% with 24-32), females 15-21 (more than 95% with 18-21); (6) pedipalp movable finger length/palm length ratio in adult males and females 1.1-1.2; (7) carapace length/pectine length ratio in adult males 0.9-1.0, adult females 1.2-1.3; (8) humerus with three (occasionally four) inframedial macrosetae on proximal 3/5 of internal surface; (9) pedipalp primary denticles, excluding proximal row, total 42-61 on fixed finger, 54-75 on movable finger; (10) adult carapace length in males 4.1-6.6 mm, females 4.8-7.2 mm.

Comparisons: the *boreus* infragroup (below) differs in characters 1-4; the *stahnkei* infragroup (below) differs primarily in characters 1-4, but also significantly in 5-10.

Distribution.—Southeastern Arizona, eastward to Big Bend region of Texas, southward to Aguascalientes in Mexico.

Included species.—*P. gracilior* (Hoffmann, 1931).

Paruroctonus gracilior (Hoffmann)

Uroctonoides gracilior Hoffmann, 1931:406, figs. 42-43; Gertsch 1958:15, 17.

Paruroctonus gracilior: Werner 1934:283, fig. 363; Stahnke 1957:253, 1961:206, 1974:136, 137, 138, figs. 10A, 11A, 11B; Williams 1972:3, 1980:31, 32, figs. 35A-B, 36C-D; Soleglad 1972:73, 1973:355, tbl. 2; Sissom and Francke 1981:97-98, 102, 107, figs. 7-12, 33-35; Francke and Soleglad 1981:242, fig. 22.

Vejovis (Paruroctonus) gracilior: Gertsch and Allred 1965:9; Gertsch and Soleglad 1966:6, 26-30, figs. 13, 18, 21, 23, 33-35, tbl. 3; Williams 1968a:7.

Hoffmanniellus gracilior: Gertsch and Soleglad 1966:26 (in synonymy); Williams 1972:3 (in synonymy). Misspelling of *Hoffmanniellus* Mello-Leitão, 1934:80.

Vejovis (Paruroctonus) pallidus Williams 1968a:6-11, figs. 4-6, tbl. 2; Diaz-Nájera 1975:7, 20. **NEW SYNONYMY.**

Paruroctonus pallidus: Williams, 1972:3; Soleglad 1972:73, 1973:355, tbl. 2; Stahnke 1974:138; Sissom and Francke 1981:98, 102.

Uroctonus gracilior: Diaz-Nájera 1975:2 (erratum).

Vaejovis gracilior: Diaz-Nájera 1975:2, 6, 8, 20.

Types.—*Uroctonoides gracilior*: Lectotype male (adult) from Mexico, Aguascalientes, Tepezala (C. C. Hoffmann), tagged #1. Depository: American Museum of Natural History.

Vejovis pallidus: Holotype male (adult) from Mexico, Coahuila, 0.5 kilometer SW Cuatro Cienegas (S. C. Williams, et al.). Depository: California Academy of Sciences, Type No. 10174.

Diagnosis.—See infragroup diagnosis above.

Description.—Supplementing above diagnosis, Gertsch and Soleglad (1966:26), and Sissom and Francke (1981:97). Basic fuscous pattern (see Gertsch and Soleglad 1966: figs. 18, 21) varies from dark and distinct to obsolete. Cheliceral fixed digit without denticles on inferior carina. Humeral macrosetae: internals include one supramedial, three (occasionally four) inframedials on proximal 3/5; four dorsals; usually three external medials, middle seta often small in immatures and juveniles. Brachial macrosetae: four internals. Chela: palm with eight major carinae moderately to well developed and granular in both sexes, intercarinal surfaces weakly to moderately concave; macrosetae include two or three on internal carina, usually four on ventrointernal carina, usually eight or nine flanking ventral carina, none on fixed finger, one long internal proximal and sometimes one short internal at mid-length of movable fingers; fingers essentially unscalloped in both sexes; primary denticles in seven rows on movable finger, six on fixed finger; supernumerary denticles well developed, six on fixed finger, seven on movable finger. Basitarsi I-III: not conspicuously compressed laterally; superior setae on I-III irregularly distributed, usually three distal plus two proximal on III; mrs seta on I at most only slightly offset from superior setae, on II moderately offset, on III set well apart from superior setae. Telotarsal setae I-IV: proinferiors 1,2,2,2; two each promedials, prosuperiors, retrosuperiors and retromedials; usually one retroinferior; one retroinferior terminal. Ungues I-IV about 1/3 as long as telotarsus. Pectines extend to proximal margin of femur IV in males, to 1/4 length of trochanter IV in females. Metasomal carinae: ventral and ventrolaterals I-III in males essentially smooth to crenulate (often strongly so), in females smooth to weakly crenulate, IV entirely crenulate in both sexes. Metasomal setae: counts variable; ventrals I-IV primarily 3-4,5-6,5-6,5-7; ventrolaterals I-V primarily 2-3,4,4-5,4-6, 7-15; dorsals I-IV 0,1,1,2 (fewer than 5% with 1,1,1,2).

Variation.—Some specimens from arenicolous populations had on basitarsus III, in addition to the usual 3+2 superior setae, a sixth seta (variably developed) between and prolateral to the proximal and distal groups, resulting in a 4+2 pattern; distinctly smaller extraneous setae might also be present, particularly in arenicolous specimens.

The ventrolateral metasomal seta counts varied considerably, including on V; e.g., eight to 15 (80% with nine to 12) in Texas and New Mexico, seven to nine (68% with eight) in southeastern Arizona, and seven to nine, normally eight, in Cuatro Cienegas basin of Coahuila.

Adult carapace lengths varied considerably among the samples; e.g., 4.1-5.0 mm (Chiricahua Mts., Arizona), 4.5-6.5 mm (Big Bend region, Texas), and 6.0-7.2 mm (Cuatro Cienegas basin, Coahuila).

Remarks.—*Paruroctonus pallidus*, distinguished from *P. gracilior* originally (Williams 1968a:7) by apparent differences in pigmentation and in the metasomal carinae, and further (Sissom and Francke 1981:98, 102) by apparent differences in metasomal seta counts, is here considered an arenicolous pigmentation variant of *P. gracilior*. The range in variation in the development of the metasomal carinae and the metasomal seta counts in *P. gracilior* subsumes that of *P. pallidus*. When detectable, vestigial traces of fuscosity in *P. pallidus* specimens conform to the general pattern characteristic of *P. gracilior*. The

Table 1.—Diagnostic characteristics of the four microgroups constituting the boreus infragroup of the nominate subgenus *Paruroctonus*.

Character	<i>xanthus</i>	<i>becki</i>	<i>boreus</i>	<i>baergi</i>
Carapace length/cheliceral fixed digit length	7.0-9.0	5.5-6.5	7.0-9.0	7.0-9.0
Pedipalp movable finger length/palm length	1.4-1.6	1.1-1.3	1.1-1.2	1.1-1.2
Pedipalp primary denticles, rows on movable finger	7	6-7	6	6
less proximal row, fixed finger	>80	<80	<80	<80
movable finger	>90	<90	<90	<90
Pedipalp fingers, scalloping:				
(A) not, (B) proximally only, (C) multiscalloped	♂ C	A	A,B	B
	♀ C	A	A	A
Basitarsus II mid-retrosuperior seta (A) present (B) absent	B	A	A	B
Basitarsus III superior setae: (A) in distal plus proximal rows, (B) in single file	10-11 B	6 A	6 A	7-11 A,B
Telotarsi II-IV retroinferior terminal setae	2	1	2	2
Telotarsi III retrosuperior setae	6-7	2	2	2-4

amount of fuscosity typical of a population is often correlated with the darkness of the substrate, and in several *Paruroctonus* species considerable variation in pattern intensity exists (Haradon 1983:253, 261).

The above synonymy is based on the examination of *P. pallidus* paratypes (CAS, OFF); the lectotype and two cotypes of *P. gracilior* (AMNH); and approximately 120 other specimens of *P. gracilior* from previously reported material (Gertsch and Soleglad 1966; Sissom and Francke 1981) from Arizona, New Mexico, Texas and Chihuahua.

BOREUS INFRAGROUP

Diagnosis.—An infragroup of nominate subgenus *Paruroctonus* differentiated by combination of: (1) cheliceral fixed digit with inferior carina extending proximally at least to level of bicuspid (see Gertsch and Soleglad 1966:fig. 39); (2) cheliceral movable digit with superior distal tine elongate and curved, inferior distal tine length/superior distal tine length ratio less than 3.0; (3) carapace length/cheliceral fixed digit length ratio 5.5-9.0; (4) basitarsus III with six or more superior setae, arranged in distal plus proximal rows (4+2 to 5+2) or in essentially single file; (5) pectinal teeth in males 24-39 (except 20-23 in some populations of *P. bantai* and *P. baergi*, or rarely 23 in several other species), females 18-24 (except some populations 16-17 in *P. bantai* and 13-17 in *P. baergi*, or rarely 17 in several other species); (6) pedipalp movable finger length/palm length ratio in adult males and females 1.1-1.6; (7) carapace length/pectine length ratio in adult males 0.8-1.0, adult females 1.2-1.4 (except 1.6-1.8 in *P. utahensis*); (8) humerus with three inframedial macrosetae on proximal 3/5 of internal surface (except two in *P. baergi*); (9) pedipalp primary denticles, excluding proximal row, total 25-90 fixed finger, 35-103 movable finger (rarely 35 or 36); (10) adult carapace length generally 4.5-6.0 mm in males, 5.0-7.0 mm in females.

Comparisons: The gracilior infragroup (above) differs in characters 1-4; the stahnkei infragroup (below) differs primarily in character 5, but also significantly in 6-10. Exceptional males with fewer than 24/24 and females with fewer than 17/18 pectinal teeth differ from the stahnkei infragroup in having 35 or more primary denticles (less proximal row) on pedipalp movable finger in combination with either dorsal metasomal setae I-IV 0,0,0,1 (*P. bantai*), or mrs seta absent on basitarsus II and either three internal inframedial macrosetae on humerus or one retromedial seta on telotarsus III (baergi group).

Distribution.—Western North America, southern Canada southward into northern Baja California Norte, Sonora and Chihuahua in Mexico.

Subordinate taxa.—The boreus infragroup comprises four primarily allopatric elements, differentiated as follows and in Table 1.

BOREUS MICROGROUP. Diagnosis: combination of carapace length/cheliceral fixed digit length ratio 7.0-9.0; basitarsus II with mrs seta. Distribution: Rocky Mountains region westward to Pacific coastal mountains (excluding northwest coast), southern Canada southward to northern Arizona and northern Baja California Norte (excluding Mojave and Sonoran Deserts). Included taxa: *P. boreus* (Girard, 1854); *P. silvestrii* (Borelli, 1909); *P. bantai* (Gertsch and Soleglad, 1966); *P. bantai saratoga*, n. ssp.; *P. arnaudi* Williams, 1972.

BECKI MICROGROUP. Diagnosis: carapace length/ cheliceral fixed digit length ratio 5.5-6.5. Distribution: Western and southern Great Basin, southwestward through Mojave Desert to San Jacinto Mountains and edge of Colorado Desert in California. Included species: *P. becki* (Gertsch and Allred, 1965).

XANTHUS MICROGROUP. Diagnosis: pedipalp primary denticles, excluding proximal row, total 82-90 on fixed finger, 98-103 on movable finger; pedipalp movable finger length/palm length ratio 1.4-1.6 in both sexes; pedipalp fingers multi-scalloped in adults of both sexes (see Gertsch Soleglad 1966:fig. 32); telotarsus III with six or seven retro-superior setae. Distribution: Sand dunes, southeastern California and extreme north-western corner of Sonora. Included species: *P. xanthus* (Gertsch and Soleglad, 1966).

BAERGI MICROGROUP. Diagnosis: combination of carapace length/ cheliceral fixed digit length ratio 7.0-9.0; pedipalp primary denticles on movable finger in six rows; basitarsus II without mrs seta. Distribution: Loose sandy soils, primarily dunes, associated with Colorado River and Rio Grande drainages, from southern Utah to northern Mexico. Included species: This microgroup, named after *P. baergi* (Williams and Hadley, 1967), and including *P. utahensis* (Williams, 1968b), is discussed in detail by Haradon (1984a).

Remarks.—The boreus and gracilior microgroups, where sympatric with the arenicolous baergi microgroup, occupy more compact soils; the boreus microgroup, where sympatric with the becki microgroup, tends to occupy higher elevations.

Paruroctonus boreus (Girard)

Figs. 1-2

Scorpio (Telegonus) boreus Girard, 1854:267-269, zool. plt. xvii, figs. 5-7 (in part, not record from Eagle Pass, Texas).

Buthus boreus: Wood 1863a:110, 1863b:368.

Vejoavis boreus: Marx 1888:91; Gertsch 1958:6 (in part, not synonymy with "*Vejoavis silvestrii*").

Vaejoavis boreus: Ewing 1928:12; not Bugbee 1942:320 (= *Paruroctonus utahensis*; see Sissom and Francke 1981:94); not Diaz-Nájera 1975:13 (= *Paruroctonus silvestrii*).

Vejoavis aquilonalis Stahnke, 1940:101.

Vejoavis (Paruroctonus) boreus: Gertsch and Allred 1965:9 (in part, not synonymy with "*Vejoavis silvestrii*"); Gertsch and Soleglad 1966:7.

Vejovis (Paruroctonus) aquilonalis: Gertsch and Allred 1965:9; Gertsch and Soleglad 1966:42 (in part, see Sissom and Francke 1981:94).

Vejovis (Paruroctonus) auratus Gertsch and Soleglad, 1966:7 (key), 34, 44-47 (description), figs. 55, 58, tbl. 6 (in part, holotype only). **NEW SYNONYMY.**

Vaejovis (Paruroctonus) boreus: Hjelle 1972:22.

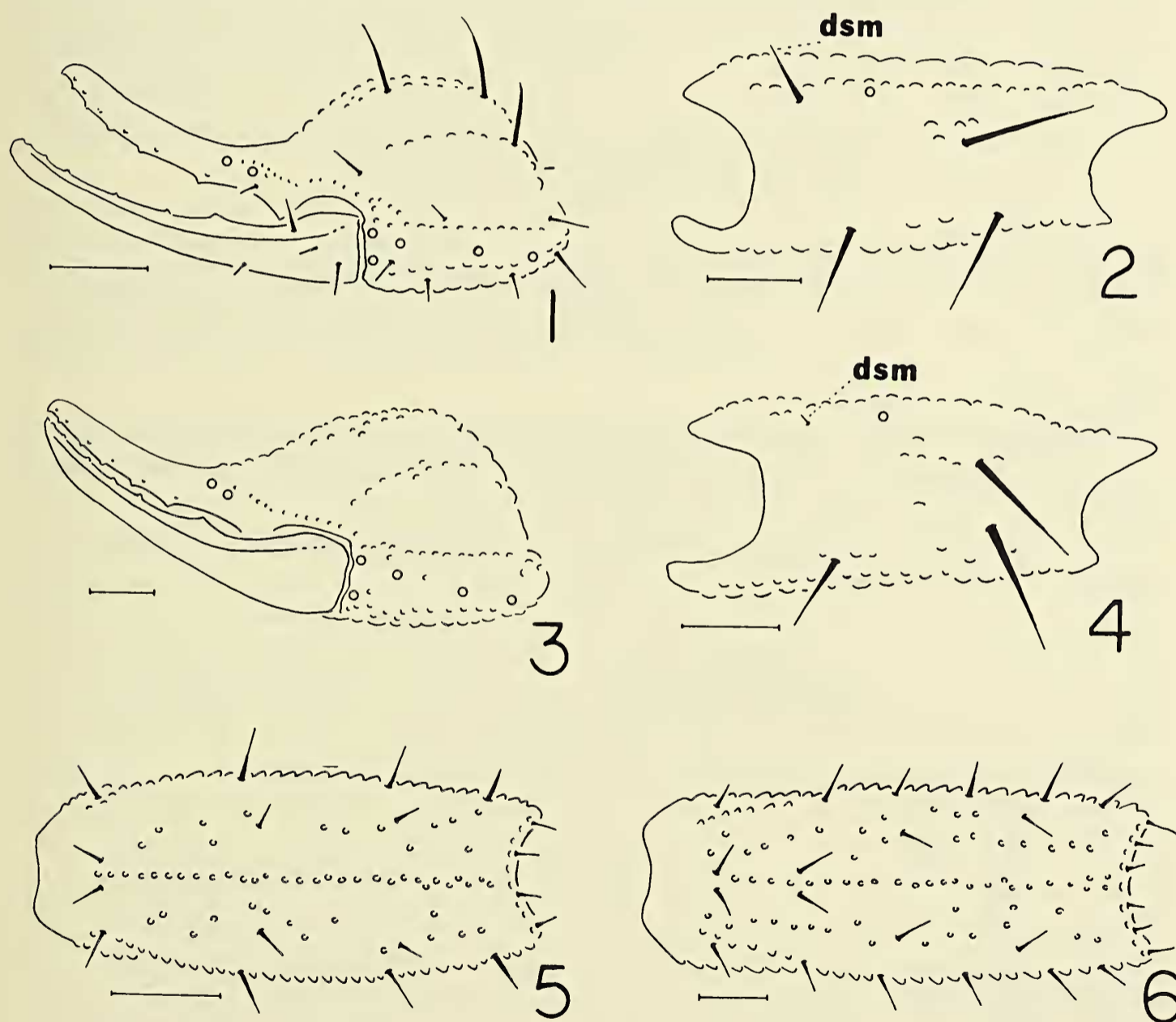
Paruroctonus aquilonalis: Williams 1972:3; Soleglad 1972:74, 1973:355, Stahnke 1974:138; Sissom and Francke 1981:94.

Paruroctonus auratus: Williams 1972:3, 1976:2, 1980:47; Soleglad 1972:75 (in part), 1973:355 (in part); Stahnke 1974:138; Sissom and Francke 1981:96 (in part).

Paruroctonus boreus: Williams 1972:3, 1976:2; Soleglad 1972:74, 1973:355; Stahnke 1974:138; Sissom and Francke 1981:93.

Type.—*Scorpio (Telegonus) boreus*: Female (adult) from the "Valley of the Great Salt Lake of Utah", collected by "Capt. Howard Stansbury". Depository: United States National Museum.

Girard (1854) based his description of *P. boreus* on a single specimen, which was last reported to have been examined by Marx (1888). The 18 pectinal teeth reported by Girard (1854:267, 268, fig. 6) indicate the original specimen to be a female.



Figs. 1-4.—Right pedipalpal segments, internal views: 1, *P. boreus*, chela; 2, *P. boreus*, brachium; 3, *P. bantai*, chela; 4, *P. bantai*, brachium. Key: dsm = distal supramedial seta; circle = trichobothrium. Scale = 1.0 mm.

Figs. 5-6.—Metasomal segment V, ventral views: 5, *P. bantai bantai*; 6, *P. bantai saratoga*, n. ssp. Scale = 1.0 mm.

Remarks.—*Paruroctonus boreus* is the most widely mentioned *Paruroctonus* species in the technical and popular literature (often combined with *Vaejovis* or *Vejovis*), and the above synonymy includes only the first citation of each name, major taxonomic accounts, new synonyms and misidentifications. The bibliographic data given herein for Girard (1854), a report contained in a rare volume, corrects a recurring error that began with Wood (1863b:369).

The above diagnosis of *P. boreus* is based primarily on specimens from the Great Basin, including the Great Salt Lake Desert. The inter- and intrapopulation variability of many other characters in *P. boreus* is considerable, and still being studied.

Examination of the holotype of the nominal species *Paruroctonus auratus* revealed no significant differences between it and the Great Salt Lake Desert (topotypic) population of *P. boreus*. The subtle differences in metasomal and telson proportions between *P. auratus* and *P. boreus* reported by Gertsch and Soleglad (1966:45) were found to be insignificant using large samples of the latter species. As in certain other congeners (see Remarks to gracilior infragroup above), many arenicolous populations of *P. boreus*, including the topotypic populations of *P. boreus* and *P. auratus*, have essentially lost the basic fuscous pattern characteristic of this species (see Gertsch and Soleglad 1966:figs. 6, 8), and simply represent pigmentation variants.

Paruroctonus bantai (Gertsch and Soleglad)

Figs. 3-6

Vejovis (Paruroctonus) bantai Gertsch and Soleglad, 1966:6 (key), 20-23 (description), figs. 12, 22, 29, tbl. 2; Williams and Hadley 1967:112; Williams 1970:8.

Paruroctonus bantai: Williams 1972:3, 1976:2; Soleglad 1972:75, 1973:355, tbl. 2; Stahnke 1974:138.

Type.—*Vejovis bantai*: Holotype female (adult) from U.S.A., California, Inyo County, Saline Valley, Warm Springs Road, Station 94, 8 May 1960 (B. Banta). Depository: California Academy of Sciences, Type No. 10193.

Diagnosis.—A species of subgenus *Paruroctonus*, boreus infragroup (chelicerel fixed digit with inferior carina extending proximally to level of bicusps; pectinal teeth 20-28 in males, 16-20 in females; pedipalp primary denticles, excluding proximal row, 28-35 on fixed finger, 37-49 on movable finger), and boreus microgroup (carapace length/chelicerel fixed digit length ratio 7.0-9.0; basitarsus II with mrs seta), differentiated by combination of: (1) pedipalp fingers in adult male deeply scalloped proximally, closed fingers form wide gap, in adult female weakly scalloped, closed fingers form narrow gap; (2) fuscous markings generally absent in interocular triangle and do not extend to posterior margin on tergites II-VI; (3) ventrolateral metasomal setae on IV 3, on V 4 or 6; (4) ventral metasomal setae I-IV 3,3,3,3-4; (5) dorsal metasomal setae I-IV 0,0,0,1; (6) ventrolateral metasomal carinae I-III granular; (7) ventral metasomal carinae I-III smooth to granular; (8) brachium with three long macrosetae on internal surface, dsm seta inconspicuous (Fig. 4); (9) pedipalp chelal macrosetae inconspicuous or absent (Fig. 3), except occasionally one short proximal on internal or ventrointernal carina, especially in females and juveniles.

Comparisons: *P. silvestrii* differs in characters 1-9, *P. arnaudi* differs in characters 2-9, and *P. boreus* differs in characters 5-9 (see *P. boreus* diagnosis above).

Description.—Supplementing above diagnosis and Gertsch and Soleglad (1966:20). Adult carapace lengths in males 4.9-6.2 mm, in females 5.5-7.4 mm. Chelicera: fixed digit with denticles on inferior carina; on movable digit, superior distal tine elongate and

curved, about $1/2$ as long as inferior distal tine. Trichobothria typical of genus in number and distribution. Humeral macrosetae: internals include one supramedial, three inframedials on proximal $3/5$; four dorsals; usually three external medials, middle seta smallest and occasionally absent. Chela: supernumerary denticles well developed, six on fixed finger, seven on movable finger. Basitarsi I-III: not conspicuously compressed laterally; superior setae on I 2+2 or 3+2, II 3+2 or 4+2, III 4+2; mrs seta on I-III stout, short and distinctly offset from superior setae. Telotarsal setae I-IV: proinferiors 1,2,2,2; two each promedials, prosuperiors, retrosuperiors, retromedials; retroinferiors 1,1,2,2; retroinferior terminals 1-2,2,2,2. Ungues about $3/5$ as long as telotarsus. Pectines in adult males extend to about $3/4$ length of trochanter IV, in adult females to slightly beyond coxa IV or to about $1/3$ length of trochanter IV. Telson setae: two long ventroanteriorly, two long at subaculear tubercle, others short or inconspicuous.

Distribution.—Saline Valley and southern Death Valley, California

Remarks.—Two subspecies of *P. bantai* are delimited as follows.

Paruroctonus bantai bantai (Gertsch and Soleglad)

Figs. 3-5

Synonymy.—Same as for species (see above).

Diagnosis.—A subspecies of *P. bantai* differentiated by combination of: ventrolateral metasomal setae on segment II 2 (90% of specimens), on V 4 (Fig. 5) (fifth seta, if present, smaller and offset from others); ventral metasomal setae on segment IV 3 (90% of specimens), on V 3 (rarely 4); pectinal teeth in males (79%) 23 or fewer, females (75%) 17 or fewer.

Comparisons: *P. bantai saratoga*, n. ssp., differs in all five characters (see diagnosis below).

Table 3.—Numbers of pectinal teeth in subspecies of *Paruroctonus bantai* and *Paruroctonus shulovi*, and in *Paruroctonus simulatus*, n. sp.

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
<i>P. b. bantai</i>																		
Males										3	13	9	10	6	3			
Females						4	20	7	1									
<i>P. b. saratoga</i>																		
Males												3	3	13	21	11	7	2
Females						1	7	32	23	1								
<i>P. s. shulovi</i>																		
Males								6	12	15	6							
Females	1	4	33	44	11													
<i>P. s. nevadae</i>																		
Males										1	4	7						
Females				2	7	9	4											
<i>P. simulatus</i>																		
Males								1	2	10	9	4	1	1				
Females		1	4	8	4	7	2											
<i>P. coahuilanus</i>																		
Males								2	6	11	6	1						

Variation.—Total adult length of males 37-50 mm, females 50 mm. Adult carapace length of males 4.9-6.2 mm, females 5.5-6.6 mm. Variation in the numbers of metasomal setae is presented in Table 2. Pectinal tooth counts in males 20-25, females 16-19 (Table 3). Pedipalp primary denticles, excluding proximal row, total 28-35 (32.15 ± 1.91 , $n = 39$) on fixed finger, 37-47 (41.77 ± 2.01 , $n = 39$) on movable finger. The dsm seta on the internal brachial surface, and the chelal internal setae, are generally inconspicuous from the late immature state on.

Distribution.—Saline Valley, California.

Specimens examined.—U.S.A.: CALIFORNIA; *Inyo County*, Saline Valley, 21 September 1971 (D. Giuliani), 1 male (CAS), Saline Valley, June 1959 (B. Banta), 7 males, 4 females (CAS), 4 July 1959 (B. Banta), 2 males, 3 females (CAS), 5 July 1959 (B. Banta), 3 males, 2 females (CAS), 22 November 1959 (B. Banta), 2 males (CAS), 27 November 1959 (B. Banta), 6 males (CAS), 28 November 1959 (B. Banta), 1 males, 1 female (CAS), 3 March 1960 (B. Banta), 1 male (CAS), 6 March 1960 (B. Banta), 1 female (CAS), 3 April 1960 (B. Banta), 1 male, 2 females (CAS), 8 May 1960 (B. Banta), 1 male (CAS), 3 April 1962 (B. Banta), 1 male, 3 females (CAS).

Paruroctonus bantai saratoga, new subspecies

Fig. 6

Type.—*Paruroctonus bantai saratoga*: Holotype male (adult) from U.S.A., California San Bernardino County, Death Valley Natl. Mon., Saratoga Springs, salt flats, 11 June 1970 (M. A. Cazier, L. Welch, O. F. Francke). Depository: California Academy of Sciences, Type No. 15057.

Diagnosis.—A subspecies of *P. bantai* differentiated by combination of: ventrolateral metasomal setae on segment II 3, on V 6 (Fig. 6); ventral metasomal setae on segment IV 4, on V 4 (72% of specimens); pectinal teeth in males (90%) 24 or more, females (87%) 18 or more.

Comparisons: *P. bantai bantai* differs in all five characters (see diagnosis above).

Description of male holotype.—Measurements: Table 4. Pedipalp primary denticles on fixed fingers 4,5,7-6,8,10-8,12-14, movable fingers 5,8-6,9,9-11,14,9-10. Metasomal setae: dorsals 0,0,0,1; dorsolaterals 0,1,1,2; laterals 1,0,0,0,2; ventrolaterals 2,3,3,3,6; ventrals 3,3,3,4,4.

Allotype.—Measurements in Table 4.

Variation.—Total adult length of males 50-60 mm, females 50-60 mm. Adult carapace length of males 5.2-6.1 mm, females 6.0-7.4 mm. Variation in the numbers of metasomal setae is presented in Table 2. Pectinal teeth in males 22-28, females 16-20 (Table 3). Pedipalp primary denticles, excluding proximal row, total 28-35 (32.26 ± 1.38 , $n = 62$) on fixed finger, 39-49 (43.81 ± 2.16 , $n = 62$) on movable finger. The dsm seta on the internal brachial surface, and the chelal internal setae, are generally inconspicuous or absent in subadult and adult specimens.

Etymology.—The name "saratoga" refers to the type locality.

Distribution.—Salt flats at Saratoga Springs, southern Death Valley, California.

Specimens examined.—Paratypes. U.S.A.: CALIFORNIA; *San Bernardino County*, Death Valley Natl. Mon., Saratoga Springs, 11 June 1970 (M. A. Cazier, L. Welch, O. F. Francke), 29 males, 31 females (OFF), allotype (CAS).

STAHNKEI INFRAGROUP

Diagnosis.—An infragroup of nominate subgenus *Paruroctonus* differentiated by combination of: (1) cheliceral fixed digit with inferior carina extending proximally at

Table 4.—Measurements (in millimeters) of type specimens of new *Paruroctonus* species and subspecies. L = length, W = width, D = depth.

	<i>P. bantai saratoga</i>		<i>P. shulovi nevadae</i>	<i>P. simulatus</i>		<i>P. coahuilanus</i>
	Holotype male	Allotype female	Holotype female	Holotype male	Allotype female	Holotype male
Total L	50.7	56.2	40.6	38.6	41.6	41.6
Carapace L	6.1	7.0	4.5	4.4	5.3	5.0
Mid-length W	5.0	5.5	3.6	3.6	4.0	4.0
Posterior W	5.8	6.5	4.6	4.0	4.8	4.6
Median eyes W	1.2	1.4	1.0	1.0	1.0	1.0
Mesosoma L	13.8	17.4	10.5	10.7	12.7	11.4
Metasoma I L/W	3.2/3.1	3.3/3.6	2.2/2.2	2.6/2.2	2.5/2.4	2.8/2.7
II L/W	3.9/3.0	3.9/3.4	2.6/2.0	3.0/2.1	2.9/2.2	3.2/2.6
III L/W	4.1/2.8	4.1/3.2	2.8/2.0	3.2/2.0	3.1/2.1	3.4/2.4
IV L/W	5.1/2.8	5.1/3.2	3.4/1.8	4.0/1.8	3.9/2.0	4.2/2.2
V L/W	7.6/2.8	7.7/3.2	5.2/1.8	5.8/1.8	6.0/2.0	6.1/1.9
Telson L/W	6.9/2.7	7.7/3.4	4.7/1.9	5.0/1.7	5.2/2.2	5.4/1.6
Ampulla L/D	4.0/2.3	4.3/2.6	2.8/1.6	3.0/1.4	3.4/1.7	3.2/1.4
Chelicera palm L/W	1.6/1.3	2.4/1.6	1.5/1.2	1.0/1.0	1.3/1.2	1.4/0.9
Fixed digit L	0.8	0.9	0.6	0.6	0.7	0.9
Movable digit L	1.5	1.6	1.2	1.0	1.4	1.5
Humerus L/W	5.1/1.7	5.6/2.0	3.6/1.2	4.0/1.2	4.4/1.4	3.8/1.4
Brachium L/W	5.4/2.3	5.9/2.3	4.0/1.2	4.0/1.6	4.6/1.8	4.0/1.7
Pedipalp palm L/W	5.3/4.8	6.0/5.0	3.9/2.6	4.0/2.6	4.4/2.9	4.7/2.9
Fixed finger L	4.6	5.1	3.2	3.0	3.7	2.9
Movable finger L	6.4	6.8	4.2	4.0	4.9	4.2
Pectine L	6.2	5.2	3.2	4.6	3.9	4.4
Dentate L	5.9	4.1	2.4	3.9	2.8	3.8
Basal L/W	1.7/1.4	1.7/1.2	1.0/0.6	1.0/0.9	1.2/0.8	—
Pectinal teeth	25/25	19/18	15/15	21/21	16/16	19/19

least to level of bicuspid (see Gertsch and Soleglad 1966:fig. 36); (2) cheliceral movable digit with superior distal tine essentially triangular or elongate and curved, inferior distal tine length/superior distal tine length ratio 3.0 or less; (3) carapace length/cheliceral fixed digit length ratio 4.2-8.0; (4) basitarsus III with six or more superior setae, arranged in distal plus proximal rows (4+2 to 6+2) or in essentially single file; (5) pectinal teeth in males 13-23 (except 26-27 in one new species; rarely 24 in *P. stahnkei* or *P. simulatus*, n. sp.), females 8-17 (except 18 in one new species); (6) pedipalp movable finger length/palm length ratio in adult males 0.8-1.0 (except 1.0-1.1 in shulovi microgroup), adult females 1.0-1.1; (7) carapace length/pectine length ratio in adult males 1.0-1.2, adult females 1.5-2.2 (except 1.4-1.5 in *P. stahnkei*, and 1.4 in shulovi microgroup); (8) humerus with two inframedial macrosetae on proximal 3/5 of internal surface (except two to three in shulovi microgroup); (9) pedipalp primary denticles, excluding proximal row, total 17-47 on fixed finger, 22-57 on movable finger; (10) adult carapace length generally 3.0-5.0 mm in males, 3.5-5.5 mm in females.

Comparisons: the gracilior infragroup (above) differs primarily in characters 1-4, but also significantly in 5-10; the boreus infragroup (above) differs primarily in character 5, but also significantly in 6-10. Specimens with pectinal tooth counts exceeding 23/24 in males or 17/17 in females (see Haradon, 1984b) have 34 or fewer primary denticles on pedipalp movable finger; all species in the boreus infragroup have 35 or more primary denticles on the movable finger.

Distribution.—Western and southern Great Basin, southward into Sonoran Desert and Baja California Sur; also Chihuahuan Desert.

Subordinate taxa.—The *stahnkei* infragroup comprises four primarily allopatric elements, differentiated as follows and in Table 5.

STAHNKEI MICROGROUP. Diagnosis: combination of carapace length/ cheliceral fixed digit length ratio 4.2-5.0; telotarsi II-IV with one retroinferior terminal seta (similar to Fig. 16). Distribution: Northern Sonoran Desert. Included species: *P. stahnkei* (Gertsch and Sologlad, 1966).

SHULOVI MICROGROUP. Diagnosis: combination of carapace length/ cheliceral fixed digit length ratio 7.0-8.0; basitarsus II with mrs seta. Distribution: Western and southern Great Basin. Included taxa: *P. shulovi* (Williams, 1970); *P. shulovi nevadae*, n. ssp.; *P. simulatus*, n. sp.

BORREGOENSIS MICROGROUP. Diagnosis: basitarsus II without mrs seta. Distribution: Southern Great Basin, southward into northwestern Sonora and northern Baja California Sur. Included species: This microgroup, named after *P. borregoensis* Williams, 1972, is discussed in detail by Haradon (1984b).

WILLIAMSI MICROGROUP. Diagnosis: combination of carapace length/cheliceral fixed digit length ratio 4.8-5.8; telotarsi II-IV with two retroinferior terminal setae. Distribution: Chihuahuan Desert. Included species: *P. williamsi* Sissom and Francke, 1981; *P. pecos* Sissom and Francke, 1981; *P. coahuilanus*, n. sp.

Paruroctonus shulovi (Williams)

Figs. 7-10, 15, 17-20

Vejovis (Paruroctonus) shulovi Williams, 1970:7-11, figs. 5, 6, tbl. 3.

Paruroctonus shulovi: Williams 1972:3, 1976:2, tbl. 1; Sologlad 1972:74, 1973:355, tbl. 2; Stahnke 1974:138.

Type.—*Vejovis shulovi*: Holotype female (adult) from U.S.A., California, Inyo County, Death Valley Natl. Mon., Grapevine Spring, 4 miles E Ubehebe Crater, 12 April 1968 (S. C. Williams, V. F. Lee, J. Bigelow). Depository: California Academy of Sciences.

Diagnosis.—A species of subgenus *Paruroctonus*, *stahnkei* infragroup (cheliceral fixed digit with inferior carina extending proximally to level of bicuspid; pectinal teeth 18-22 in males, 11-17 in females; pedipalp primary denticles, excluding proximal row, 24-31 on fixed finger, 34-42 on movable finger; basitarsus II with mrs seta; dorsal metasomal setae I-IV 0,1,1,2), and *shulovi* microgroup (carapace length/cheliceral fixed digit length ratio 7.0-8.0; cheliceral fixed digit with denticles on inferior carina), differentiated by: (1) telotarsi II-IV with two retroinferior terminal setae (Fig. 15); (2) basitarsus III with seven (5+2) superior setae (Figs. 9-10); (3) pedipalp fingers in adult male deeply scalloped proximally, closed fingers form wide gap (Fig. 19), in adult female weakly to moderately scalloped proximally, closed fingers form narrow to moderate gap (Fig. 21); (4) pedipalp palm length/width ratio in adult males 1.3-1.4.

Comparisons: *P. simulatus*, n. sp., differs in characters 1-4 (see below).

Description.—Supplementing above diagnosis and Williams (1970:7). Total adult length of male 35-40 mm, females 35-45 mm. Adult carapace length of males 3.8-4.8 mm, females 4.2-5.6 mm. Trichobothria typical of genus in number and general distribution. Humeral macrosetae: internals include three inframedials on proximal 3/5, one supramedi- al; four dorsals; usually two external medials on distal 3/5, small middle seta occasionally present. Brachial macrosetae: four internals. Chela: supernumerary denticles well

developed, six on fixed finger, seven on movable finger; primary denticles in six rows on both fingers; macrosetae include two on internal carina (both long), two on ventrointernal carina (proximal long, distal short), one short internal on fixed finger, two internal on movable finger (proximal long, mid-length short). Basitarsus I-III: slightly compressed laterally; superior setae on I 3+2 irregularly set, II 4+2, III 5+2; mrs seta on I long and in line with proximal superior setae, on II about 2/3 as long as superior setae and generally set well apart from superior setae. Telotarsi I-IV setae: proinferiors 1,2,2,2; two each promedials, prosuperiors, retrosuperiors and retromedials; retroinferiors and retroinferior terminals 1,2,2,2. Pectines in adult males extend to 2/3 to 3/4 length of trochanter IV, adult females to or slightly beyond distal edge of coxa IV. Metasomal setae: dorsals 0,1,1,2; dorsolaterals 0,1,1,2; laterals 1,0,0,0,2; ventrolaterals 3,4,4,5,6-8; ventrals 3,4,4,5. Telson of adult male granular.

Variation.—Pedipalp palm length/width ratio in adult males 1.3-1.4 (1.32 ± 0.02 , $n = 9$), adult females 1.4-1.6 (1.46 ± 0.05 , $n = 39$). Variation in other characters is discussed under subspecies.

Distribution.—Death Valley in California, and southern Nevada.

Paruroctonus shulovi shulovi (Williams)

Figs. 7-10, 15, 17, 19-20

Synonymy.—Same as for species (see above).

Diagnosis.—A subspecies of *P. shulovi* differentiated by combination of: pectinal posterior basal length/maximum basal width ratio in adult females 1.8-2.3 (1.96 ± 0.11 , n

Table 5.—Distribution and diagnostic characteristics of the four microgroups constituting the *stahnkei* infragroup of the nominate subgenus *Paruroctonus*.

Character	<i>stahnkei</i>	<i>williamsi</i>	<i>shulovi</i>	<i>borregoensis</i>
Desert region	Sonoran	Chihuahuan	Great Basin	Mojave to Vizcaino
Carapace length/cheliceral fixed digit length	4.2-5.0	4.8-5.8	7.0-8.0	6.8-8.6
Cheliceral fixed digit, inferior denticles (A) absent (B) present	A	A	B	B
Pedipalp movable finger length/palm length, adult male	1.0	0.9-1.0	1.0-1.1	0.8-1.0
Pedipalp primary denticles, rows on movable finger	7	6-7	6	6
less proximal row, fixed finger	37-47	27-34	24-34	17-30
movable finger	43-57	33-43	34-44	22-38
Pedipalp fingers, adult male:				
(A) unscalloped, (B) scalloped	A	A	B	A,B
Pedipalp palm carinae, adult female: (A) granular, (B) smooth	A	B	A	B
Humeral internal inframedial macrosetae	2	2	2-3	2
Basitarsus II mid-retrosuperior seta (A) present, (B) absent	A	A	A	B
Telotarsi II-IV retroinferior terminal setae	1	2	1-2	2
Carapace length/pectine length ♀	1.4-1.5	1.6	1.4	1.5-2.2

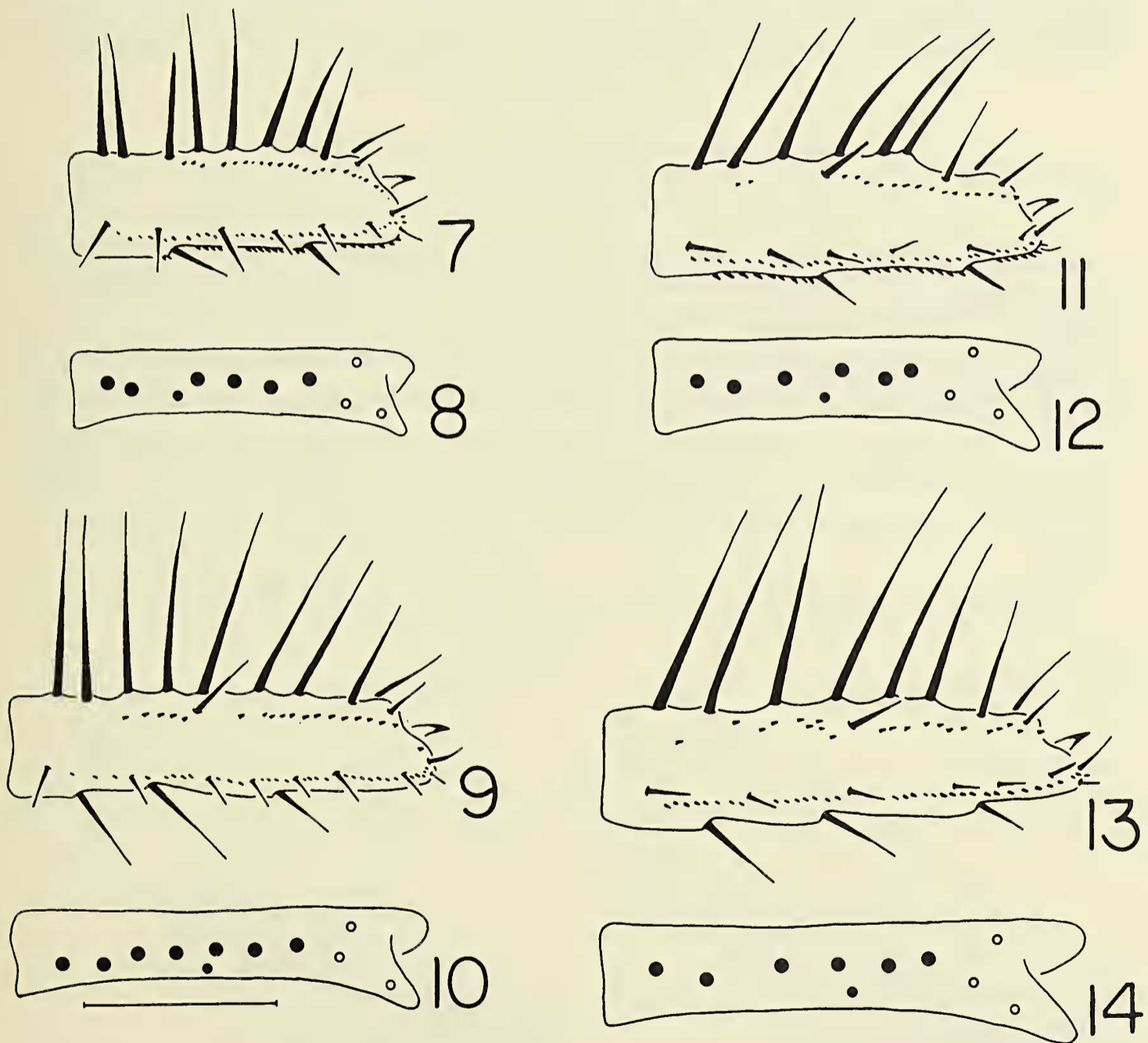
= 49); pectine length/dentate margin length ratio in adult females 1.4-1.6 (1.54 ± 0.05 , $n = 49$) (Fig. 17); pectinal teeth in males (85%) 18-20, females (88%) 11-14; metasomal segment V with 7/7 or fewer ventrolateral setae (78% of specimens).

Comparisons: *P. shulovi nevadae*, n. ssp., differs significantly in all four characters (see below).

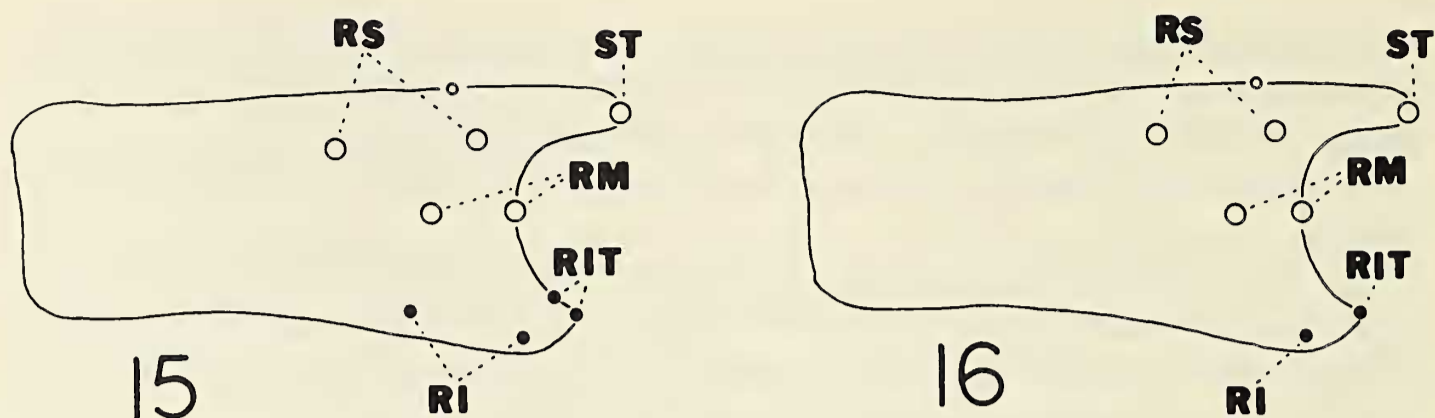
Variation.—Pectinal tooth counts varied as in Table 3. Ventrolateral setae on metasomal segment V (sample $n = 58$) varied as follows: 6/6 (15), 6/7 (20), 7/7 (10), 7/8 (10), 8/8 (3); seventh and eighth setae were generally smaller than and offset from other six. Pedipalp primary denticles, excluding proximal row, 24-31 (28.51 ± 1.63 , $n = 45$) on fixed finger, 34-42 (37.72 ± 2.12 , $n = 43$) on movable finger.

Distribution.—Northern Death Valley, California.

Specimens examined.—U.S.A.: CALIFORNIA; *Inyo County*, Death Valley Natl. Mon., Scotty's Ranch (3000 feet), 13 April 1968 (M. A. Cazier, et al.), 3 males 25 females (CAS, OFF), Grapevine Spring, 4 mi. E Ubehebe Crater (2100 feet), 12 April 1968 (S. C. Williams, V. F. Lee), 2 males, 8 females (CAS), 1 mi. N Ubehebe Crater (2100 feet), 12 April 1968 (S. C. Williams, V. F. Lee), 5



Figs. 7-14.—Right basitarsi. Figs. 7-10, *P. shulovi*: 7, basitarsus II, retrolateral view; 8, basitarsus II, superior view; 9, basitarsus III, retrolateral view; 10, basitarsus III, superior view. Figs. 11-14, *P. simulatus*, n. sp.: 11, basitarsus II, retrolateral view; 12, basitarsus II, superior view; 13, basitarsus III, retrolateral view; 14, basitarsus III, superior view. Key to setae: large solid circles = diagnostic superior setae; small solid circle = mid-retrosuperior (mrs) seta; small open circles = landmark setae. Scale = 1.0 mm.



Figs. 15-16.—Right telotarsi, retrolateral views: 15, *P. shulovi*; 16, *P. simulatus*, n. sp. Key to setae: solid circles = diagnostic setae; open circles = landmark setae; RI = retroinferior; RIT = retroinferior terminal; RM = retromedial; RS = retrosuperior; ST = superoterminal.

males, 4 females (CAS), N side Ubehebe Crater Rd., 1.8 mi. W jct. Hwy. 72, 14 October 1977 (J. Hjelle, W. Savary), 6 males, 4 females (CAS), Mesquite Springs Campground, 14 October 1977 (J. Hjelle, W. Savary), 1 female (CAS), Mesquite Springs, 5 June 1970 (M. A. Cazier, et al.), 4 males, 4 females (OFF), Mesquite Springs, 10 June 1970 (M. A. Cazier, et al.), 2 males, 1 female (OFF).

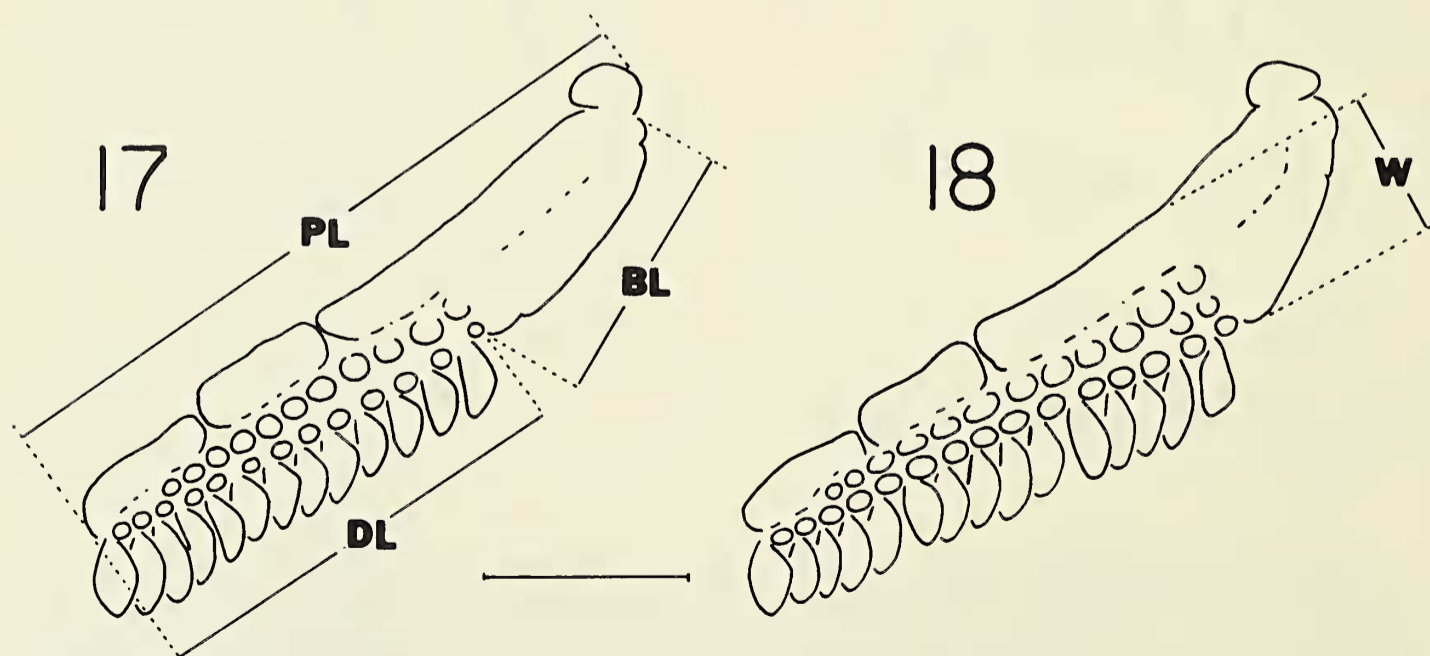
Paruroctonus shulovi nevadae, new subspecies

Fig. 18

Type.—*Paruroctonus shulovi nevadae*: Holotype female (adult) from U.S.A., Nevada, Clark County, Corn Creek Field Station, 4-5 April 1971 (S. D. Slightham). Depository: California Academy of Sciences, Type No. 15062.

Diagnosis.—Adult male unknown. A subspecies of *P. shulovi* differentiated by combination of: pectinal posterior basal length/maximum basal width ratio in adult females 1.5-1.8 (1.65 ± 0.10 , $n = 12$); pectine length/dentate margin length ratio in adult females 1.3-1.4 (1.39 ± 0.04 , $n = 12$) (Fig. 18); pectinal teeth in males (92%) 21-22, females (91%) 15-17; metasomal segment V with 7/8 or 8/8 ventrolateral setae (88% of specimens).

Comparisons: *P. shulovi shulovi* differs significantly in all four characters (see above).



Figs. 17-18.—Right pectines: 17, *P. shulovi shulovi*; 18, *P. shulovi nevadae*, n. ssp. Key: BL = basal length; DL = dentate length; PL = pectine length; W = basal width. Scale = 1.0 mm.

Description of female holotype.—Measurements: Table 4. Pedipalp primary denticles on fixed fingers 3,4,6-5,7,9-8,17, movable fingers 5,6-5,8,8,11,8. Metasomal setae: dorsals 0,1,1,2; dorsolaterals 0,1,1,2; laterals 1,0,0,0,2; ventrolaterals 2,3,3,4,7-8; ventrals 3,4,4,5.

Variation.—Pectinal tooth counts varied as in Table 3. Ventrolateral setae on metasomal segment V (sample n = 17) varied as follows: 6/7 (1), 7/7 (1), 7/8 (9), 8/8 (6). Pedipalpal primary denticles, excluding proximal row, total 26-31 (28.65 ± 1.40 , n = 23) on fixed finger, 35-42 (38.12 ± 1.68 , n = 24) on movable finger.

Etymology.—The name “nevadae” refers to the state to which this subspecies is largely restricted.

Distribution.—Southern Nevada and extreme southeastern Inyo County, California.

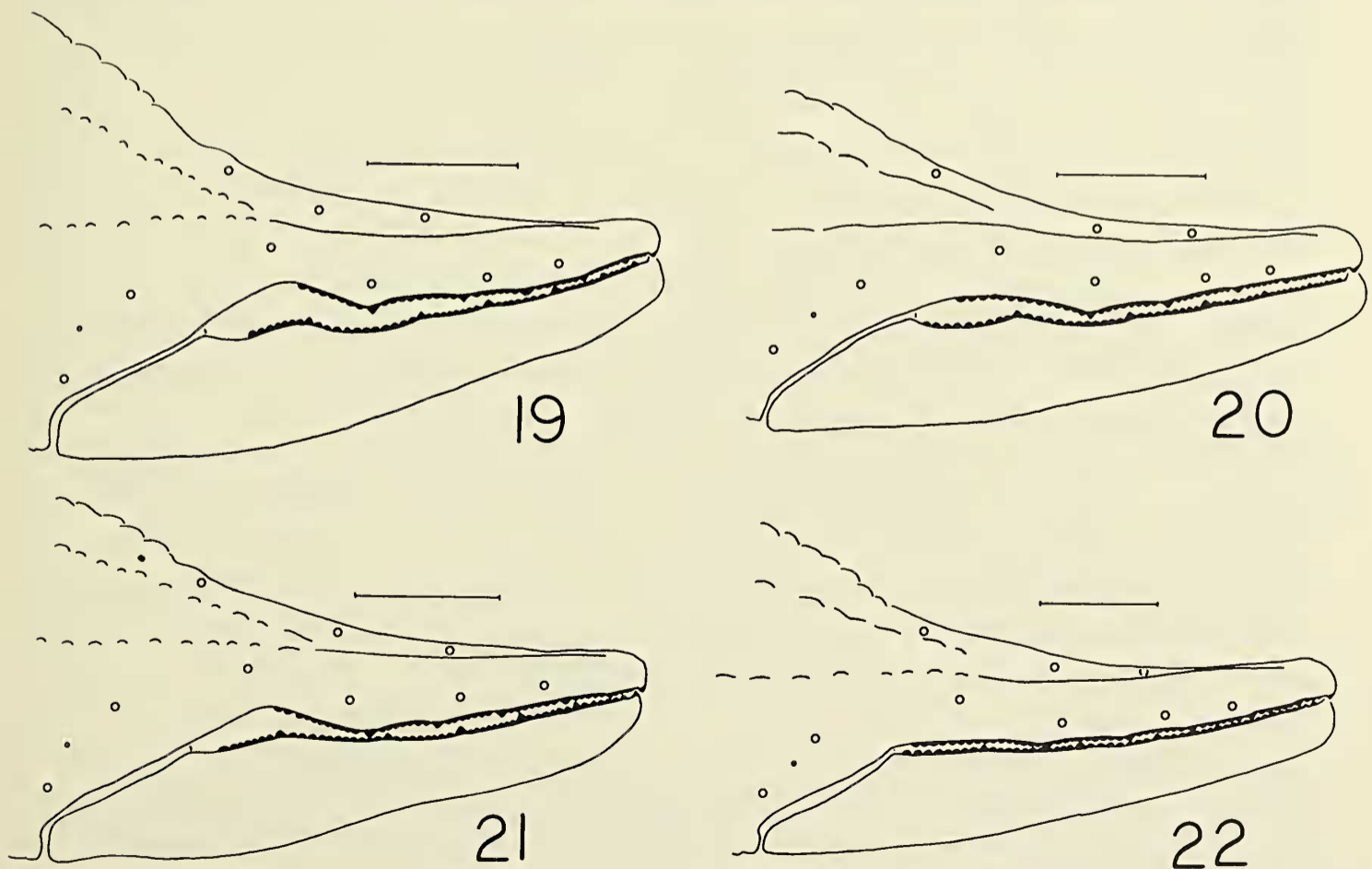
Specimens examined.—Paratypes. U.S.A.: NEVADA; *Clark County*, Corn Creek Station, 4-5 april 1971 (S. D. Slightham), 4 males, 10 females (CAS); *Nye County*, 0.8 mi. N California-Nevada border, along State Rt. 29, 12 August 1974 (R. M. Haradon, W. E. Savary), 1 female (CAS); CALIFORNIA; *Inyo County*, 5 mi. N Tecopa (1400 feet), 1 February 1970 (V. Lee), 1 male (CAS).

Paruroctonus simulatus, new species

Figs. 11-14, 16, 21-22

Type.—*Paruroctonus simulatus*: Holotype male (adult) from U.S.A., Nevada, Mineral County, 7 miles N Hawthorne, dunes SE Walker Lake, 15 August 1974 (R. M. Haradon, W. E. Savary). Depository: California Academy of Sciences, Type No. 15063.

Diagnosis.—A species of subgenus *Paruroctonus*, *stahnkei* infragroup (cheliceral fixed digit with inferior carina extending proximally to level of bicuspid; pectinal teeth 18-24 in males, 12-17 in females; pedipalp primary denticles, excluding proximal row, 29-34 on fixed finger, 38-44 on movable finger; basitarsus II with mrs seta; dorsal metasomal setae



Figs. 19-22.—Right pedipalp fingers, adult state, external views: 19, *P. shulovi*, male; 20, *P. shulovi*, female; 21, *P. simulatus*, n. sp., male 22, *P. simulatus*, n. sp., female. Scale = 1.0 mm.

I-IV 0,1,1,2), and shulovi microgroup (carapace length/cheliceral fixed digit length ratio 7.0-8.0; cheliceral fixed digit with denticles on inferior carina), differentiated by: (1) telotarsi II-IV with one retroinferior terminal seta (Fig. 16); (2) basitarsus III with six (4+2) superior setae (Figs. 13-14); (3) pedipalp fingers in adult male moderately scalloped proximally, closed fingers form moderate gap (Fig. 20), in adult female essentially unscalloped, closed fingers form at most a very narrow gap (Fig. 22); (4) pedipalp palm length/width ratio in adult males 1.5-1.6.

Comparisons: *P. shulovi* (see above) differs in characters 1-4.

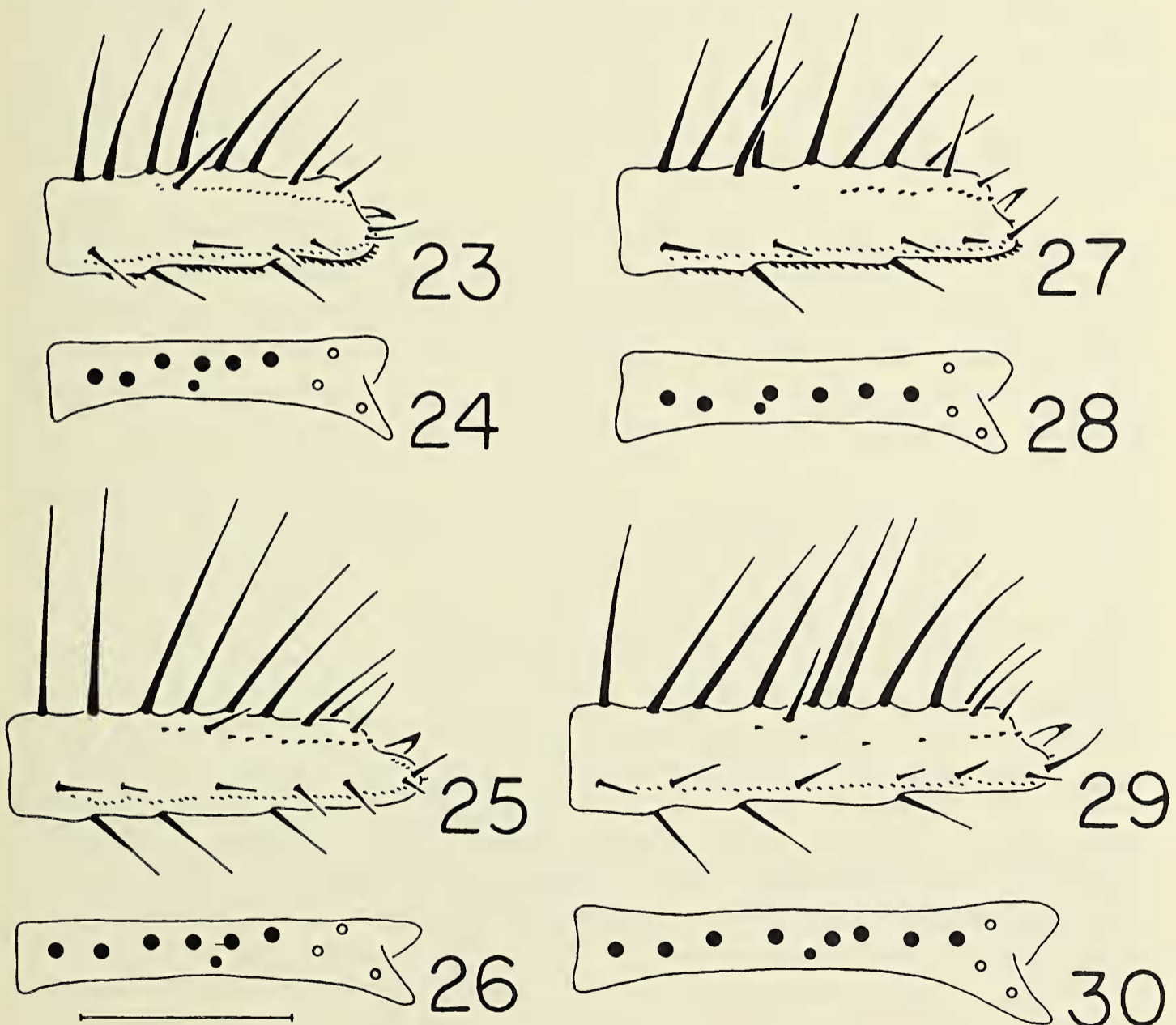
Description of male holotype (allotype).—Measurements: Table 4. Pigmentation: pale brownish yellow with fuscous markings on carapace, tergites, pedipalps, legs and ventral surface of metasoma. Carapace: anterior margin straight; surface coarsely (moderately) granular; furrows and carinae well developed. Tergites: I-VII anterior elevated area smooth, posterior area finely granular in anterior half and coarsely (sparsely) granular in posterior half; median carina I-II weakly developed (obsolete), III-VII moderately developed, granular (weak, lightly granular); VII with two pairs granular lateral carinae. Sternites: III-VI very finely granular (smooth), VII moderately (finely) granular with one pair weak carinae. Chelicera: fixed digit with one denticle on inferior carina, subdistal tine meets third superior tine of movable digit; movable digit with superior distal tine elongate and curved, about 1/3 as long as inferior distal tine. Trichobothria typical of genus in number and distribution. Humerus: all carinae well developed, granular; intercarinal surfaces lightly to moderately (lightly) granular; macrosetae include three internal inframedials on proximal 3/5, one internal supramedial, four dorsals, two external medials on distal 3/5. Brachium: all carinae well developed, granular; intercarinal surfaces finely granular; four internal macrosetae. Chela: eight major carinae well developed, granular (lightly to moderately granular); intercarinal surfaces concave, finely granular; macrosetae include two on internal carina (both long), two on ventrointernal carina (proximal long, distal short), none on internal surface of fixed finger, one long internal proximal on movable finger; supernumerary denticles well developed, six on fixed finger, seven on movable finger; primary denticles on fixed fingers 4,6-5,8-7,7-6,7,13-11, movable fingers 5,7-8,8,8,10-11,8-9. Basitarsi I-III: not compressed laterally; superior setae on I 2+2, or 2+3 including mrs seta, II and III 4+2; mrs seta only partially differentiated from superior setae on I, distinctly offset from superior setae on II and III. Telotarsal setae I-IV: proinferiors 1,2,2,2; two each promedials, prosuperiors, retrosuperiors, retro-medials; one each retroinferior; one each retroinferior terminal, one extraneous very slender seta on III right and IV left. Ungues I-IV about half as long as telotarsus. Pectines extend to distal margin of trochanter IV (slightly beyond coxa IV). Metasomal carinae: dorsals I-IV serrate (crenulate); dorsolaterals I-IV serrate (crenulate), V granular; laterals I crenulate to serrate, II granular posterior 1/3 (few posterior granules), III with few posterior granules, IV obsolete, V granular anterior 1/2 (1/3); ventrolaterals well developed, I-II granular posterior 1/3 (few posterior granules), III with few posterior granules, IV irregularly crenulate to serrate posterior 1/2, V granular to dentate; ventrals I moderately (weakly) developed, smooth, II-III moderately to well developed, smooth, IV irregularly granular to strongly granular, V dentate; intercarinal surfaces very finely granular except V with scattered coarser granules ventrally. Metasomal setae: long; dorsals 0,1,1,2; dorsolaterals 0,1,1,2; laterals 1,0,0,0,2; ventrolaterals 2,3,3,3,6; ventrals 3,4,4,4-5. Telson: ventral and lateral surfaces granular (with few vestigial granules); nine pairs long ventral and lateral setae.

Variation.—Total adult length of males 32-40 mm, females 36-50 mm. Adult carapace length of males 3.4-4.6 mm, females 4.0-5.6 mm (except one specimen 6.6 mm). Pedipalp palm length/width ratio in adult males 1.5-1.6 (1.51 ± 0.03 , $n = 13$), adult females 1.5-1.6 (1.55 ± 0.04 , $n = 12$). Pectinal tooth counts varied as in Table 3. Pedipalp primary denticles, excluding proximal row, total 29-34 (31.53 ± 1.54 , $n = 19$) on fixed finger, 38-44 (41.33 ± 1.97 , $n = 18$) on movable finger. Ventral metasomal setae varied 3,4,4-5,4-5, usually 3,4,4,5; ventrolateral setae on segment V (sample $n = 27$) varied as follows. 6/6 (20), 6/7 (6), 7/8 (1); seventh and eighth setae on V usually smaller than and offset from other six.

Etymology.—The name “simulatus” refers to the close similarity of this species to its apparent sister species, *P. shulovi*.

Distribution.—Western Nevada and northern Inyo County, California.

Specimens examined.—Paratypes. U.S.A.: NEVADA; *Mineral County*, 7 mi. N Hawthorne, sand dunes SE Walker Lake, 15 August 1974 (R. M. Haradon, W. E. Savary), 6 males, 2 females, allotype (CAS); *Esmeralda County*, 5 mi. NW Coaldale, 17 December 1972 (collector unknown), 1 male (CAS); CALIFORNIA; *Inyo County*, Eureka Valley, sand dunes, 4 September 1975 (D. Giuliani), 1 male, 1



Figs. 23-30.—Right basitarsi. Figs. 23-26, *P. pecos*: 23, basitarsus II, retrolateral view; 24, basitarsus II, superior view; 25, basitarsus III, retrolateral view; 26, basitarsus III, superior view. Figs. 27-30, *P. coahuilanus*, n. sp.: 27, basitarsus II, retrolateral view; 28, basitarsus II superior view; 29, basitarsus III, retrolateral view; 30, basitarsus III, superior view. Key to setae: large solid circles = diagnostic superior setae; small solid circle = mid-retrosuperior (mrs) seta; small open circles = landmark setae. Scale = 1.0 mm.

female (CAS), Saline Valley, Racetrack Valley Rd. (1950-2100 feet), 27 November 1959 (B. Banta), 2 males, 1 female (CAS), Saline Valley, Grapevine Canyon Rd. (2300-3400 feet), 27 November 1959 (B. Banta), 1 male, 2 females (CAS), Death Valley Natl. Mon., along Grapevine Canyon Rd., 32 mi. NW jct. Hwy. 190, 13 October 1977 (J. Hjelle, W. E. Savary), 3 males, 4 females (CAS).

Paruroctonus coahuilanus, new species

Figs. 27-30

Type.—*Paruroctonus coahuilanus*: Holotype male (adult) from Mexico, Coahuila, Cuatro Ciénegas basin, 14 August 1968 (S. C. Williams, M. A. Cazier, J. Bigelow). Depository: California Academy of Sciences, Type No. 15059.

Diagnosis.—Female unknown. A species of subgenus *Paruroctonus*, *stahnkei* infragroup (cheliceral fixed digit with inferior carina extending proximally to level of bicuspid; pectinal teeth 18-22 in males; pedipalp primary denticles excluding proximal row, 25-28 on fixed finger, 32-38 on movable finger; basitarsus II with mrs seta; dorsal metasomal setae I-IV 1,1,1,2), and *williamsi* microgroup (carapace length/ cheliceral fixed digit length ratio 4.8-5.6; telotarsi II-IV with two retroinferior terminal setae; cheliceral fixed digit without denticles on inferior carina), differentiated by: basitarsus III (Figs. 29-30) with six distal plus two proximal (6+2) superior setae (occasionally 5+2 on one leg only).

Comparisons: *P. williamsi* and *P. pecos* differ in having four distal plus two proximal (4+2) superior setae on basitarsus III (Figs. 25-26); *P. williamsi* differs further in having 1,3,3,3 dorsal metasomal setae on I-IV.

Description of holotype male.—Measurements: Table 4. Pigmentation: uniformly pale yellow, except fuscous markings about median ocular tubercle. Carapace: anterior margin protrudes slightly medially; surface granular; furrows and carinae well developed. Tergites: I-VII anterior elevated area smooth, posterior area finely granular in anterior half and coarsely granular in posterior half; median carina I-II weak, III-VII moderately developed, granular; VII with two pairs granular lateral carinae. Sternites: III-VI very finely granular, VII finely granular with one pair weak lateral carinae. Chelicera: fixed digit without denticles on inferior carina; similar to *P. williamsi* and *P. pecos* (see Sissom and Francke 1981:figs. 27-28, 31-32). Trichobothria typical of genus in number and distribution, as in *P. williamsi* and *P. pecos* (see Sissom and Francke 1981:figs.13-26). Humerus: all carinae well developed, coarsely granular; intercarinal surfaces lightly granular; macrosetae include one internal suprmedial, two internal inframedials on proximal 3/5; four dorsals; three external medials on distal 3/5. Brachium: all carinae well developed, coarsely granular; intercarinal surfaces finely granular; four internal macrosetae. Chela: eight major carinae moderately developed; external carina irregularly and weakly granular, other carinae irregularly to moderately granular; intercarinal surfaces finely granular, moderately concave; supernumerary denticles well developed, six on fixed finger, seven on movable finger; primary denticles on fixed finger 3-2,4,5,5-6,6-7,13-12, movable finger 3,6-7,7,7,9-10,9-8; macrosetae include one long on internal carina, two on ventrointernal carina (proximal long, distal short), one long internal proximal on movable finger. Basitarsi I-III: moderately compressed laterally; superior setae on I six, irregularly distributed, on II 4+2, on III 6+2; mrs seta on I not clearly differentiated from superior setae, on II moderately off set from superior setae (Figs. 27-28), on III considerably off set (Figs. 29-30). Telotarsal setae I-IV: proinferiors 1,2,2,2; two each promedials, prosuperiors, retrosuperiors, retromedials; retroinferiors 1,1,2,2; retroinferior terminals 1,2,2,2. Ungues about 3/5 as long as telotarsus. Pectines extend to about mid-length of trochanter IV. Metasomal carinae: dorsals well developed, strongly crenulate; dorsolaterals I-IV

strongly crenulate, V coarsely to moderately granular; laterals I crenulate, II-III with few posterior granules, IV obsolete, V present and granular anterior 1/4 only; ventrolaterals I-IV well developed, granular, V dentate; ventrals I-II moderately developed, lightly granular, III-IV well developed, granular, V dentate; intercarinal surfaces finely granular, except scattered coarser granules ventrally on V. Metasomal setae: all long; dorsals 1,1,1,2; dorsolaterals 2,3,3,3; laterals 2,0,0,0,2; ventrolaterals 2,3,4,4,8; ventrals 3,3-4,4, 5. Telson: smooth; 11 pairs ventral and lateral setae.

Variation.—Total adult length 35-43 mm. Carapace length of adult males 4.2-5.1 mm. Pectinal teeth in males 18-22 (see Table 3). Three specimens (out of 13) each had on one basitarsus III seven (five distal, two proximal) superior setae instead of the normal eight (6+2). Pedipalp primary denticles (three specimens only), excluding proximal row, total on fixed finger 25-28, movable finger 32-38. Metasomal setae: dorsals 1,1,1,2, except for an occasional loss; ventrolaterals I-IV normally 2,3,3,4; ventrolaterals V with seven to 10 (95% with eight or nine); ventrals normally 3,4,4,5, except for loss or presence of individual extraneous seta.

Distribution.—Known only from the Cuatro Ciénegas basin, Coahuila, Mexico.

Etymology.—The name "coahuilanus" refers to the state of Coahuila.

Remarks.—The difference in fuscous pigmentation between *P. williamsi* and *P. pecos* reported by Sissom and Francke (1981:107) appears to reflect a difference in intensity of a basically similar but highly variable pattern. The virtual absence of fuscosity in *P. coahuilanus* is very likely only a local edaphic characteristic and not of fundamental taxonomic importance (see *P. gracilior* Remarks above).

Some males of *P. pecos* (CAS) from southern New Mexico are very similar to *P. coahuilanus* in the development of the ventral metasomal carinae, and therefore any apparent distinction in this character that might be inferred from the description of *P. pecos* by Sissom and Francke (1981:103) seems, rather, to be obscure. This character is subject to considerable sexual dimorphism in the *williamsi* and especially the *borregoensis* microgroups (i.e., males have well developed granular carinae, and females have weakly developed smooth carinae).

The three allopatric species constituting the *williamsi* microgroup are very similar, differing significantly only in the two diagnostic characters used to separate them, and possibly in the tendency of *P. coahuilanus* to have a longer mrs seta on basitarsus II (compare Figs. 23 and 27). Therefore, they might be regarded as subspecies of a single species. That they are currently isolated from one another is indicated by the fact that they have so far been found only in, and are probably restricted to, sand dunes. This would explain, also, why the less restricted species, *P. gracilior*, though sympatric with the *williamsi* microgroup and showing considerable local variation throughout that region, has remained, in contrast, a single species.

The holotypes of *P. williamsi* and *P. pecos* (AMNH) and paratypes of each (OFF, WDS) were examined, in addition to the following *P. coahuilanus* material.

Specimens examined.—Paratypes. MEXICO: COAHUILA; Cuatro Ciénegas basin, 14 August 1968 (S. C. Williams, et al.), 12 males (CAS).

PARTIAL KEY TO THE GROUPS AND SPECIES IN
THE NOMINATE SUBGENUS *PARUROCTONUS*

1. Cheliceral fixed digit inferior carina extends proximally at least to level of bicusp; carapace length/cheliceral fixed digit length ratio 4.2 or more 2
Cheliceral fixed digit inferior carina does not extend proximally to level of bicusp; carapace length/ cheliceral fixed digit length ratio 4.1 or less
. gracilior infragroup, *P. gracilior*
2. Pectinal teeth 24/24 or more in males and 17/18 or more in females and 37 or more primary denticles (less proximal row) on pedipalp movable fingers, or if fewer pectinal teeth then either (1) dorsal metasomal setae I-IV 0,0,0,1, or (2) no mrs seta on basitarsus II. boreus infragroup, 3
Pectinal teeth 23/24 or fewer in males and 17/17 or fewer in females and 36 or fewer primary denticles (less proximal row) on pedipalp movable fingers, or either (1) more pectinal teeth, or (2) more primary denticles but dorsal metasomal setae I-IV 0,1,1,1 or more and mrs seta on basitarsus II. stahnkei infragroup, 6
3. Basitarsus II with mrs seta. 4
Basitarsus II without mrs seta 5
4. Carapace length/cheliceral fixed digit length ratio 7.0 or more
. boreus microgroup, 9
Carapace length/cheliceral fixed digit length ratio 6.5 or less
. becki microgroup, *P. becki*
5. Telotarsus III with six or seven retrosuperior setae.
. xanthus microgroup, *P. xanthus*
Telotarsus III with two to four retrosuperior setae.
. baergi microgroup (see Haradon, 1984a)
6. Basitarsus II with mrs seta. 7
Basitarsus II without mrs seta borregoensis microgroup (see Haradon, 1984b)
7. Carapace length/cheliceral fixed digit length ratio 7.0 or more; cheliceral fixed digit with denticles on inferior carina. shulovi microgroup, 13
Carapace length/cheliceral fixed digit length ratio 5.8 or less; cheliceral fixed digit without denticles on inferior carina. 8
8. Telotarsi II-IV with one retroinferior terminal seta; primary denticles (less proximal row) 37 or more on pedipalp fixed finger. stahnkei microgroup, *P. stahnkei*
Telotarsi II-IV with two retroinferior terminal setae; primary denticles (less proximal row) 34 or fewer on pedipalp fixed finger williamsi microgroup, 15
9. Metasomal setae: ventrals I-IV 3,4,4,5; ventrolaterals 4 on IV and 7 on V. 10
Metasomal setae: ventrals I-IV 3,3,3,3-4; ventrolaterals 3 on IV and 4 or 6 on V 11
10. Pedipalp fingers in adult male deeply scalloped proximally, in adult female weakly scalloped *P. arnaudi*
Pedipalp fingers in adult male weakly scalloped proximally, in adult female essentially unscalloped. *P. silvestrii*

11. Metasomal dorsal setae on I-IV 0,1,1,2; ventrolateral and ventral metasomal carinae I-III smooth *P. boreus*
 Metasomal dorsal setae on I-IV 0,0,0,1; ventrolateral and ventral metasomal carinae I-III granular. *P. bantai*, 12
12. Metasomal ventrolateral setae 4 on V (Fig. 5) *P. bantai bantai*
 Metasomal ventrolateral setae 6 on V (Fig. 6) *P. bantai saratoga*, n. ssp.
13. Telotarsi II-IV with one retroinferior terminal seta (Fig. 16) *P. simulatus*, n. sp.
 Telotarsi II-IV with two retroinferior terminal setae (Fig. 15) *P. shulovi*, 14
14. Pectinal teeth 18-20 in males and 11-14 in females; pectine length/dentate margin length ratio in adult females 1.5-1.8 (Fig. 17) *P. shulovi shulovi*
 Pectinal teeth 21-22 in males and 15-17 in females; pectine length/dentate margin length ratio in adult females 1.3-1.4 (Fig. 18) *P. shulovi nevadae*, n. ssp.
15. Basitarsus III with eight (6+2) superior setae (Figs. 29-30). *P. coahuilanus*, n. sp.
 Basitarsus III with six (4+2) superior setae (Figs. 25-26) 16
16. Metasomal dorsal setae on I-IV 1,3,3,3 *P. williamsi*
 Metasomal dorsal setae on I-IV 1,1,1,2 *P. pecos*

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